ASD FieldSpec FR Calibration Setup and Techniques

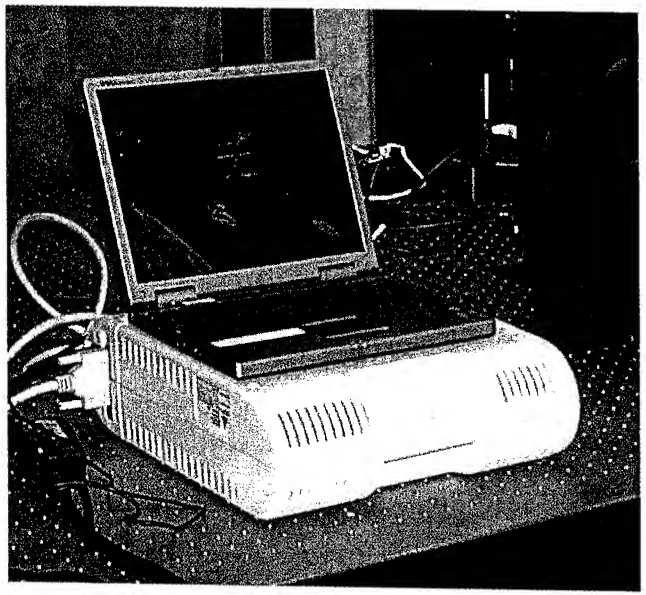
Prepared by

Dan Olive
Commercial Remote Sensing Directorate
Lockheed Martin Space Operations – Stennis Programs
John C. Stennis Space Center

October 23, 2001

ASD FieldSpec FR Spectroradiometer

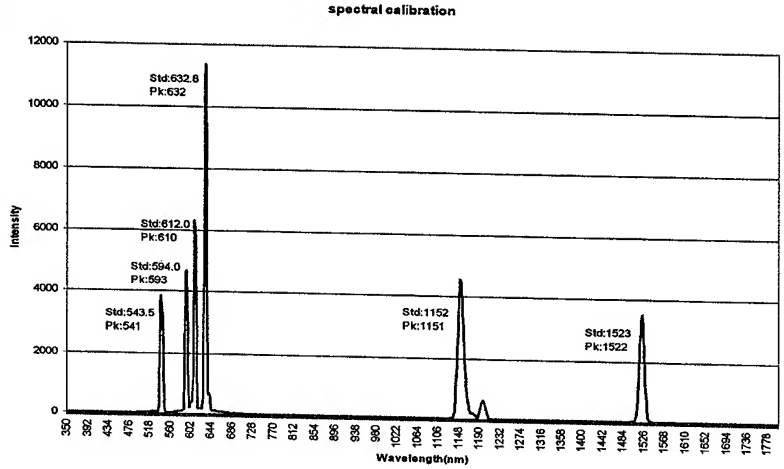
Stennis Space Center



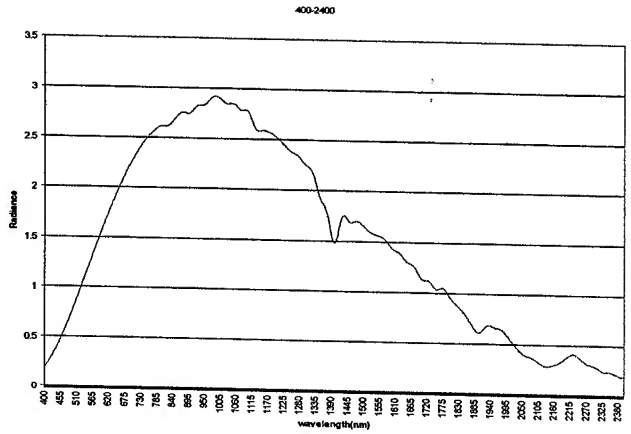
- Designed for collection of spectral data in the field
- Range is 350 to 2500 nanometers
- Measures spectral reflectance, radiance, and irradiance
- Fiber optic bundle carries light to three internal spectrometers

- UV/VIS/NIR silicon array covers about 350 to 950 nm with ~1.4 nm sample interval
- Two NIR/MWIR spectrometers cover 900 to 1850 nm and 1700 to 2500 nm with a sampling interval of about 2 to 3 nm
- Control and data storage with laptop computer
- Interchangeable foreoptics provide flexibility in field of view

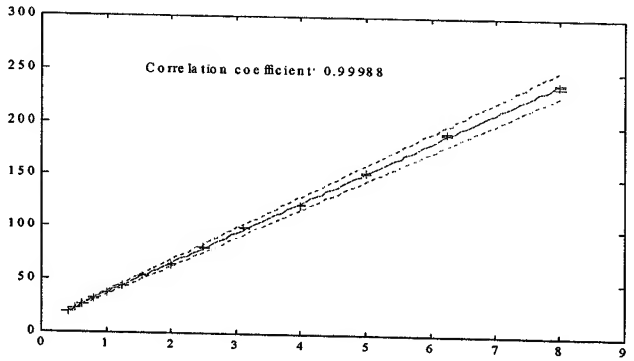
Components of Calibration



SPECTRAL



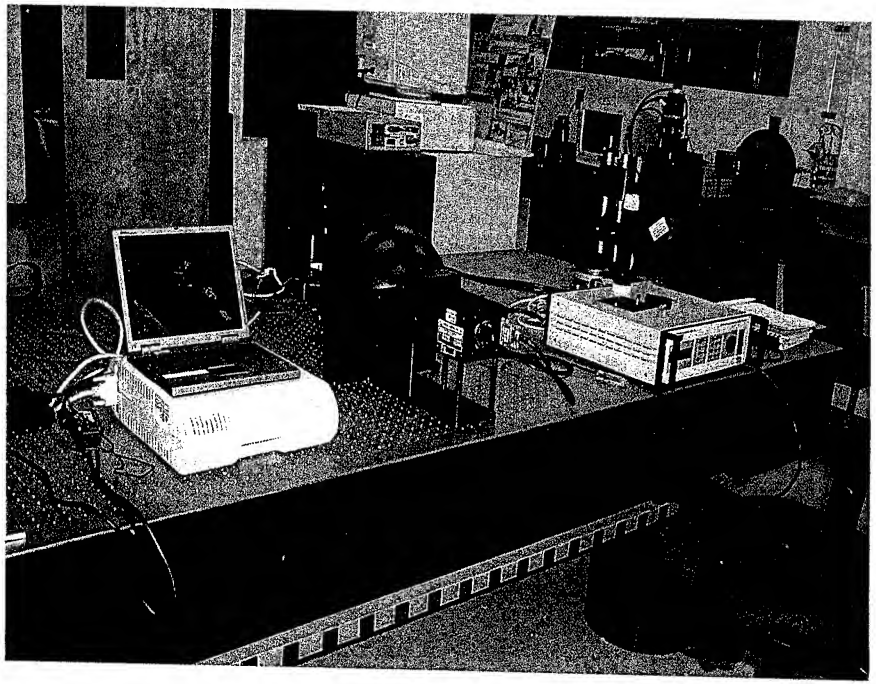
RADIOMETRIC



LINEARITY

- Spectral: Intrinsic wavelength standards
  - Lasers
  - Discharge lamps
- Radiometric: NIST secondary standard
- Linearity
- Field of View (FOV)

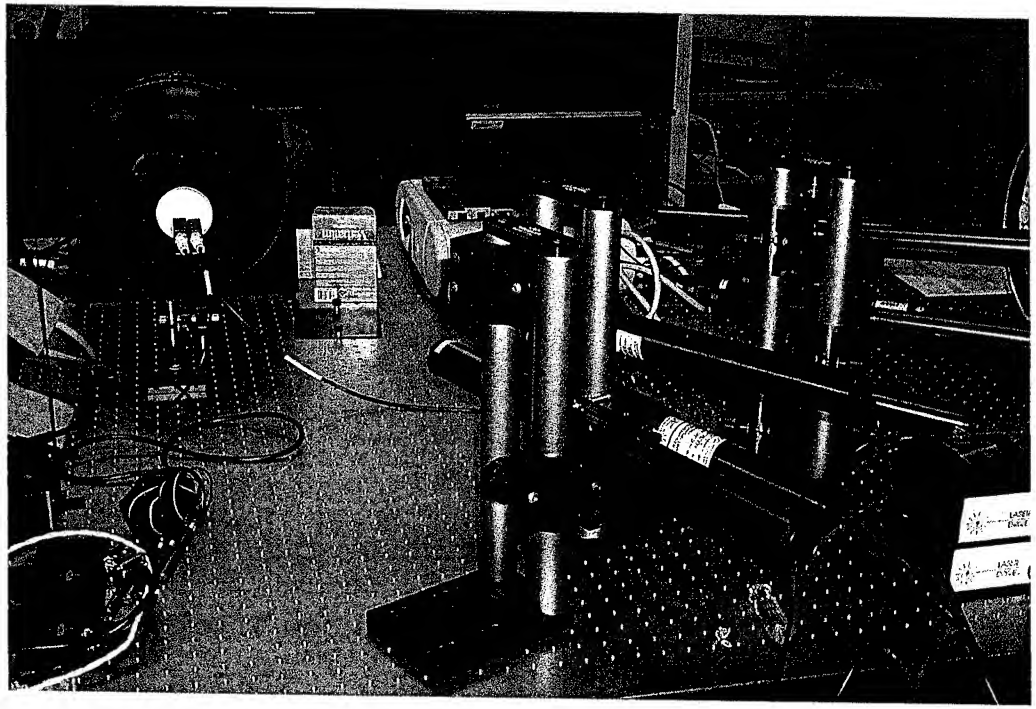
Equipment List



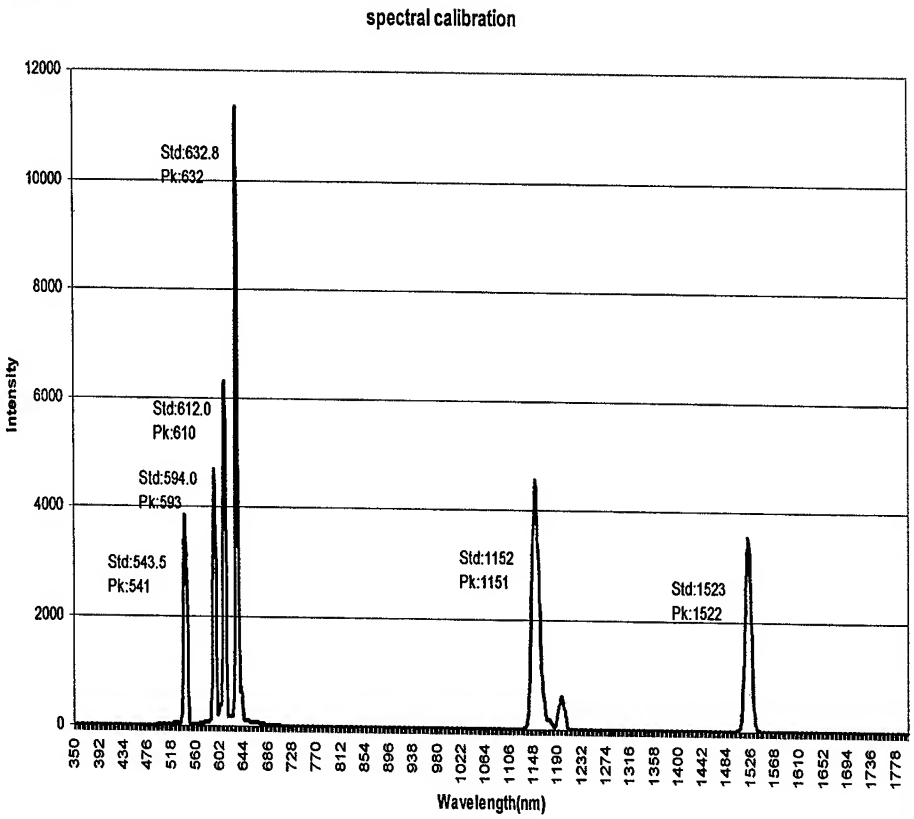
- NIST calibrated integrating sphere
- NIST sphere is equivalent to a secondary radiance standard
- Multiple HeNe lasers
- Sphere controller
- ASD FieldSpec FR spectroradiometer
- Portable laptop computer
- Precision 3-axis positioner
- MATLAB® software

Spectral Setup

- Use intrinsic spectral sources
- Six different wavelengths
- All HeNe lasers
- Beams directed into sphere
- No beams directly on baffle



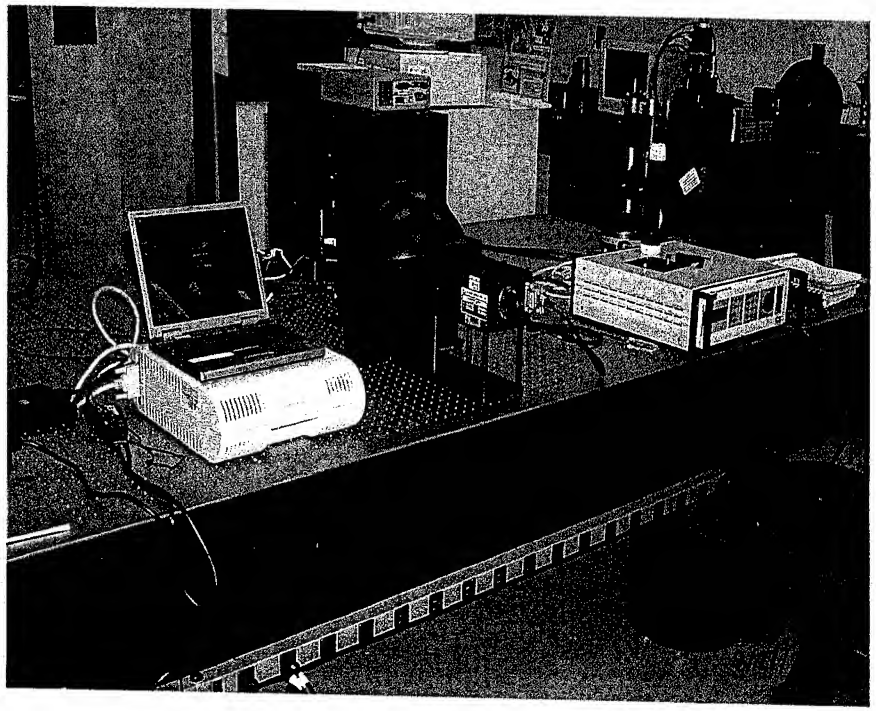
Spectral Calibration



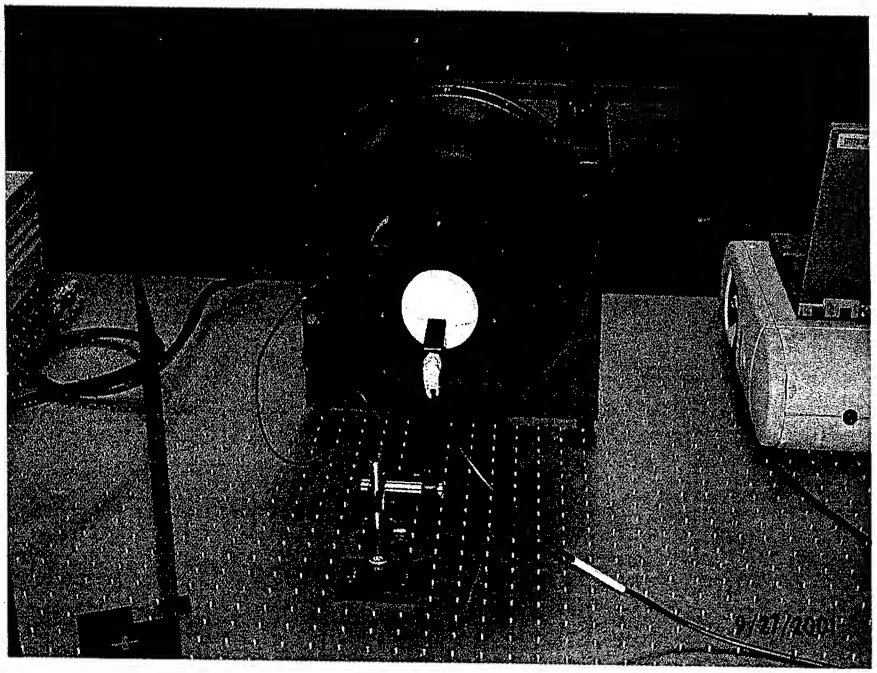
- Take raw DN data with laser input to sphere
- Determine wavelength ASD measures for each intrinsic standard
- Locally generated MATLAB code fits Gaussian to peaks and provides center wavelength and FWHM
- Calculate ASD deviations from accepted standard wavelengths

Radiometric and Linearity Setup

- ASD powered up for 1.5 hours before taking data
- Sphere port set to open away from operator
- Probe with appropriate foreoptic positioned normal to port and centered
- Room lights off for minimum stray light
- No reflective surfaces near output port



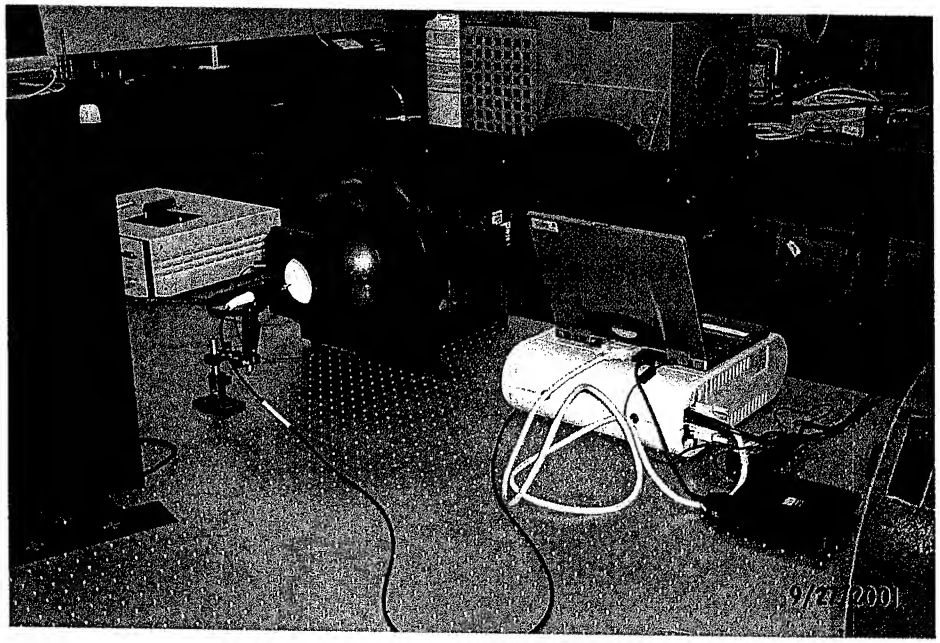
Radiometric Setup



- Entrance aperture of probe close to but not inside port output plane
- Probe is well centered
- Note edge of internal baffle
- Field of view should be considerably less than 40° to ensure total area seen is fully on the baffle surface

Datasets Required

- NIST calibration at 30.0 mW/cm^2*sr
- Equivalent to about 50% of maximum output from sphere
- Linearity requires data collection at 100%, 75%, 50%, 25%, and 10% of max
- Least squares linear fit to these points
- Use data from 50% for radiometric calibration coefficient calculation



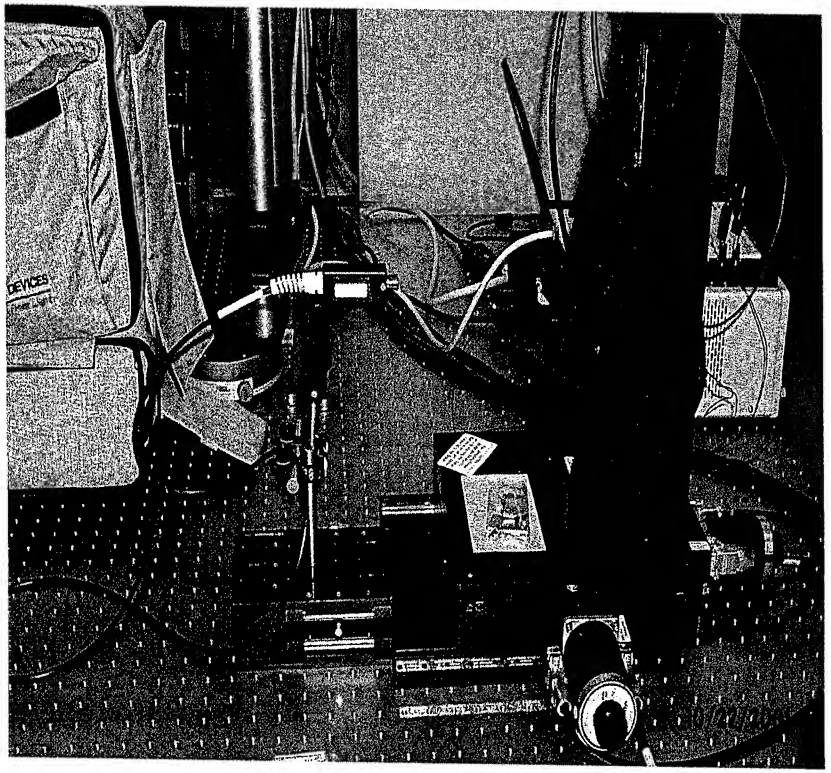
Data Files

- All data recorded as raw data files
- Each has the format HEADER.XXXX, where HEADER is created by the operator and XXXX is a number auto-incremented by the FR
- Each file has wavelength scale in one column, DN in a second column
- Files converted to text files (*.txt) with the ViewSpecPro software before analysis
- Calibration Work Instruction details entries so that each experimental data sequence produces a spectrum that is the average of 25 separate readouts
- A total of 30 of these saved spectra is generated for each experimental setup
- First step in analysis is to average these 30 files at each wavelength

Data Files (continued)

- Averaging 25 readouts for one spectrum reduces noise
- Saving 30 spectra enables statistical calculation of SNR and further reduces noise
- Spectral calibration files of laser lines are analyzed to yield center wavelength and FWHM as measured by the ASD
- Corrections (offsets) are calculated from differences between standard wavelengths and those measured by the ASD
- Spectral radiance calibration coefficients are produced from raw digital numbers recorded and NIST file of spectral radiance from the sphere
- For verification of linearity, the raw spectra are first converted to spectral radiance via the calibration coefficients
- The resultant spectral radiance file is then integrated to yield total integrated radiance, which is used to derive a least squares fit to a line

Field of View Measurement



- Precision, automated three-axis positioner moves small grain of wheat bulb through field of view
- Room darkened
- ASD takes spectrum at each position
- Spectrum is integrated to yield overall intensity and plotted as function of position in the X,Z plane
- Angular FOV reconstructed from geometry

Summary

- **Field portable spectroradiometers play key role in validation and verification**
  - Ground truth data collection
  - Radiometer transfer for internal laboratory use
- **Calibration required under ISO9000**
- **Vendor calibrations not traceable**
- **In-house calibration highly desirable**
  - Traceability ensured
  - Equipment not subject to hazards of shipping
- **Instruments serve multiple purposes**

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
25-10-2001		

4. TITLE AND SUBTITLE
ASD FieldSpec Calibration Setup and Techniques

5a. CONTRACT NUMBER
NAS13-650

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
Dan Olive

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
LMSO- Stennis Program

8. PERFORMING ORGANIZATION REPORT NUMBER
SE-2001-10-00063-SSC

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Earth Science Applications Directorate

10. SPONSORING/MONITOR'S ACRONYM(S)

11. SPONSORING/MONITORING REPORT NUMBER

12. DISTRIBUTION/AVAILABILITY STATEMENT
Publicily Available STI per form 1676

13. SUPPLEMENTARY NOTES
Conference - Presentaiton at National Council of Standards Laboratories - Regional Chapter Meeting, SSC

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19b. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Dan Olive
U		U	UU	13	19b. TELEPHONE NUMBER *(Include area code)* (228) 688-1803